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A
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IN THE
FEEDING OF CHILDREN

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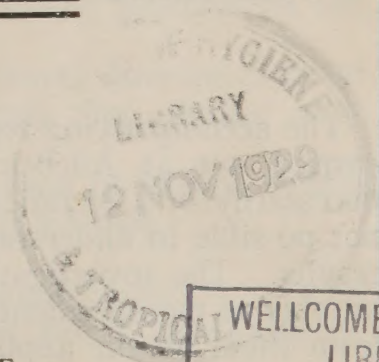
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A NOTABLE EXPERIMENT IN THE FEEDING OF CHILDREN.

Dr. Geo. A. Auden, M.A., M.D., D.P.H., F.R.C.P., School Medical Officer for the City of Birmingham Education Committee, in co-operation with Dr. James R. Mitchell, has recently carried out at the Allcock Street Council School, Birmingham, an experiment in which a pint of Milk was given daily to 30 under-nourished school children for a period of four months. It is well known that mal-nutrition generally results from a deficiency in either the quantity or the quality of the food taken, and these experiments were designed to test the value of Milk in making good the deficiency in either event. Fifteen girls and the same number of boys, all aged from 7 to 11 years, were selected, who shewed the greatest deficiency in weight for height, age, and sex, as well as a low proportion of the red colouring matter of the blood, and these children were ascertained by medical examination to be free from any active disease and were also found by the Head Teacher to be making poor progress in their school work. The experiments were duly controlled and scientifically conducted, and the conclusions arrived at by the two Doctors, as stated in their Report, are as follows :—

There was an improvement in the rate of increase in weight and in nutrition, as calculated by different methods of investigation ; a notable improvement in mental and bodily vigour and alertness ; and an improvement in the amount of the red colouring matter of the blood.

In the Report a touching fact is recorded. It was found by the examination of the same children one month after the issue of the milk had ceased, that a general slight loss in weight had taken place.

THE ALLCOCK STREET MILK DISTRIBUTION EXPERIMENT.

The accompanying report embodies the results of the experiment carried out at Allcock Street Council School. Much of this is necessarily of a technical character, but without these details it is not possible to understand fully the nature of the experiment or its results. The investigation entailed the collection of a very large number of measurements. It may be possible to elicit further facts from these by the application of mathematical formulæ, but such facts will be of a purely academic interest, and will not change the character of the general conclusions which may be drawn. The actual investigation has been carried out by Dr. James R. Mitchell, M.C., who has drawn up the chief part of this report. Through the kindness of the Mother-Superior of the Hostel of St. Brigid, Deritend, the distribution of the milk was continued throughout the Christmas holidays.



The object of this experiment was to produce evidence of the physiological value of milk as an article of diet, and particularly to discover what effect was produced on children suffering from malnutrition by the addition to their dietary of a pint of milk daily.

A daily allowance of one pint of milk each for 30 children having been arranged for by the National Milk Publicity Council, 15 suitable individuals were chosen from the Girls' Department, and an equal number from the Boys' Department. In order to exclude extraneous influences and to secure a degree of uniformity of experimental conditions, an equal number of children of both sexes was chosen between the age of 7 and 11 years. After the age of 11 the normal growth, especially that of girls, begins to be accelerated, a fact which would have introduced errors into the physical factors which were under observation. Moreover, it was necessary for the same reason to secure for the experiment children who were not already in receipt of school meals.

Method of Selection.

For the purpose of the investigation it was necessary that the children chosen should be, as far as possible, those suffering from malnutrition alone, and not the subjects of any active disease.

The Head Teachers of the departments concerned were asked to choose about 20 children each from those of their scholars who seemed to them to be poorly nourished, and particularly those who appeared to be making poor progress in their school work in consequence of this deficiency. These children were then examined and those excluded who gave evidence of active disease. The presence of carious teeth was not considered a ground for exclusion unless the mouth was septic, nor did anæmia cause rejection when this condition was not traceable to any underlying disease. The following measurements were taken in accordance with Professor Dreyer's directions in his "Assessment of Physical Fitness."

Trunk height..	..	..	in upright sitting position on the floor.
Circumference of chest	..	..	at level of fourth intercostal space in the nipple line during easy respiration.
Weight of body	..	..	unclad, a towel of known weight being used as a screen.

Dreyer's tables give :—

- (a) a normal weight corresponding to trunk height ;
- (b) a normal weight corresponding to actual chest circumference.

Dreyer takes the average of these two weights as a calculated normal weight for the individual concerned, and expresses as a percentage of it the variation of the actual weight from this normal. The value of the trunk height in preference to the total height as an index of development and nutrition is now generally recognised, and throughout this experiment Dreyer's methods have been employed.

In estimating the nutritional status of the individual, weight alone is insufficient as a guide. American observers lay considerable stress on this point, and attach great importance to clinical signs of malnutrition detected by a physician. In the present investigation the percentage of hæmoglobin present in the blood was used as an additional guide. Hæmoglobin was estimated with Von Fleischl's hæmometer.

The final selection was made of those children who showed the greatest deficiency in weight combined with a low percentage of hæmoglobin.

In order to have a standard for comparison, an equal number of children of both sexes was selected from among those who presented no signs of malnutrition. These children were subjected to an examination precisely similar to that employed in selecting the poorly nourished, and were designed to serve as "controls" in the experiment. They are in the same age-group as the "poorly nourished," and live under the same conditions as to general environment.

There were then two classes of children, each comprising 15 boys and 15 girls, both classes being in the same age-group. Throughout this report these groups are referred to as "poorly nourished" and "controls" respectively.

Originally the experiment was planned to extend through two months, but an additional supply of milk being available through the kindness of the National Milk Publicity Council, it was possible to increase the period to four months, and to arrange for an equal issue of milk to the "controls" during the second two months. The milk, from a specially selected herd, was delivered at the School by the Birmingham Dairy Co., Ltd., twice daily in half-pint sealed bottles. When required a small hole was made through the seal, and the milk drunk through a clean straw. Messrs. Hughes & Co., Ltd., generously supplied a sufficient number of Hovis biscuits for each child to have two with each bottle of milk, and as a solatium to the "controls" during the first two months. The biscuit taken with the milk has the advantage that by mingling with the milk in the stomach it prevents the formation of massive curd. Their rough texture makes the Hovis biscuits particularly useful in this respect.

The milk and biscuits were consumed at 10.15 a.m. and 3.15 p.m. All weighings, etc., were done at a uniform time of day and always before ingestion of the biscuits and milk. Experiment showed that the taking of this nourishment caused an immediate rise in weight of from 8 to 10 ozs., and this increase was not appreciably less at the end of half an hour. There was no issue of milk on Saturday afternoons but the Head Master and the Head Mistress took it in turns to attend at the School on Saturday mornings to supervise the distribution of the nourishment, and, by the kindness of the Rev. Mother-Superior of the Hostel of St. Brigid, Deritend, the regular distribution was maintained throughout the Christmas holidays. One child, a girl among the "controls" or normal children, was

unable to take milk. She, therefore, had the biscuits only during the whole course of the experiment. No difficulty in this respect was experienced with any of the other children.

Condition of the Children at the beginning of the experiment.

Calculated according to Dreyer's tables, the condition was as follows :—

Boys (poorly nourished)	..	Average defect per cent. in weight	..	..6.28
Boys (controls)	..	Average excess per cent. in weight	..	..1.45
Girls (poorly nourished)	..	Average defect per cent. in weight	..	..8.46
Girls (controls)	..	Average defect per cent. in weight	..	..1.14

Dreyer estimates that a percentage of 5, 10 or 15, above or below the calculated normal, indicates a weight, possibly, probably, or certainly, abnormal, respectively. So reckoned, all the children concerned come within the range of possible abnormality, and here is seen the value of the hæmoglobin estimation.

The average percentage of hæmoglobin in each class was as under—

Boys (poorly nourished)	..	..	..	..	61.06
Boys (controls)	..	..	..	..	79.06
Girls (poorly nourished)	..	..	..	..	57.53
Girls (controls)	..	..	..	..	76.93

The normal percentage of hæmoglobin in children is stated by Hutchison to be about 87. It will be noted that in both groups the figure for girls is lower than that for boys. This is probably no more than coincidence, since the sex inequality noted in later life has not so far been observed at eleven years of age.

Compared with Stephenson's standard of normal weight corresponding to age in children, both classes in the present instance showed a deficiency which was, however, more marked in the case of the "poorly nourished."

Average deficiency in weight (Stephenson's standard.)

Boys (poorly nourished)	..	..	13.21 lbs. or 22.56%
Boys (controls)	..	..	4.46 lbs. or 7.54%
Girls (poorly nourished)	..	..	11.25 lbs. or 18.45%
Girls (controls)	..	..	0.56 lbs. or 0.97%

Two of the children may be cited as an instance of the discrepancy between these standards :—

a) Girl (poorly nourished)	(Dreyer.	Stephenson)
Percentage defect in weight	..	8.08 46.21

(b) Girl (control)	
Percentage excess in weight	.. 0.91 30.04

a) is a girl of small build, a physique similar to that of her mother. She is, however, well proportioned.

(b) also a well-proportioned girl, but with the physique of a girl a year older.

It should be borne in mind that these standards are the average for children of all classes, city and rural, and that in the case of Stephenson's figures American statistics have been included.

A third comparison of weight is, however, possible, and is of particular interest. In the Annual Report for 1909, the School Medical Officer of Birmingham tabulated the average weights of children at various ages in different districts of the City. Taking the 8 year group as the most convenient for comparison, we find the following :—

Boys (poorly nourished) were 0·71 lbs. below the worst district, and 5·17 lbs. below the average for all districts.

Boys (controls) were 1·31 lbs. above the best district, and 6·85 lbs. above the average for all districts.

Girls (poorly nourished) were 1·74 lbs. above the worst district, and 0·50 lbs. below the average for all districts.

Girls (controls) were 1·11 lbs. above the best district, and 5·67 lbs. above the average for all districts.

These figures are quoted to show that at Allcock Street School it was possible to select a sufficient number of normal children who compared favourably with the local average.

Social Conditions.

The district in which these children live has suffered severely in the recent and continuing lack of employment. None of the children gave evidence of infestation with vermin. The clothes of the boys were notably poorer than those of the girls. Clothing, including boots, is classified below as good, fairly good, or poor, according to the state of repair of the articles and their adequacy in securing dryness and warmth for the wearer.

Clothing.	Good.	Fairly Good.	Poor.
Boys (poorly nourished)	.. 4	4	7
Boys (controls) ..	.. 8	3	4
Girls (poorly nourished)	.. 10	5	0
Girls (controls)	.. 12	3	0

The families from which the "poorly nourished" children were taken were, on the average, larger than those of which the "controls" were members. This, of course, has in most cases a double effect. Food, per head, is less plentiful and overcrowding becomes more serious. A large proportion of the houses occupied by these families is a three-apartment type which allows two bedrooms for anything up to ten, or even more, occupants. It was also noticed that in the families of the "poorly nourished" there had been a higher number of infantile deaths than in the families of the "controls."

In some instances the child showing malnutrition was stated to have been born a weakling; in others it was reported that this particular child had been weakly since some illness; such as diphtheria. Doubtless such children suffer earliest and most severely as a result of shortage of food. In one family the older members were reported fairly healthy, but two younger ones showed marked

rickets. Jansen maintains that a typical feature of feeble growth in a family is this increase of disability in successive members ; general malnutrition in the older children and actual rickets in the younger.

The tables already submitted give a record of the periodic measurements, etc., and the following is a general summary of results noted—

Condition at the end of the first two months.

Average increase in weight :

Boys (poorly nourished)	..	..	..	1.26 lbs.
Boys (controls)	..	..	..	0.28 lbs.
Girls (poorly nourished)	..	..	..	2.53 lbs.
Girls (controls)	..	..	..	1.76 lbs.

Average increase in percentage of hæmoglobin :

Boys (poorly nourished)	..	..	..	9.34.
Boys (controls)	..	..	..	0.14.
Girls (poorly nourished)	..	..	..	7.53.
Girls (controls)	..	..	..	2.67.

During this period one boy in each category increased in height of trunk, the increase being one-eighth of an inch in each case. Among the girls, two increased in this respect by one-eighth of an inch, while five of the "controls" showed increase—4 by one-eighth, and 1 by $\frac{1}{4}$ inch.

None of the "poorly nourished" boys showed any increase in circumference of chest ; two of the boy "controls" had increased by one-eighth inch. Among the girls (poorly nourished) one had increased by one-eighth inch, whilst six of the "controls" showed increase ranging from one-eighth inch to one-quarter inch.

Condition at the end of the second two months.

Average increase of weight (during second two months) :

Boys (poorly nourished)	..	..	..	1.13 lbs.
Boys (controls)	..	..	..	1.83 lbs.
Girls (poorly nourished)	..	..	..	0.98 lbs.
Girls (controls)	..	..	..	1.16 lbs.

Average increase in percentage of hæmoglobin :

Boys (poorly nourished)	..	..	..	2.81.
Boys (controls)	..	..	..	0.26.
Girls (poorly nourished)	..	..	..	4.54.
Girls (controls)	..	..	..	3.54.

During this second period 8 of the "poorly nourished" boys increased in trunk height—6 by one-eighth, and 2 by one-quarter of an inch, while 11 of the "controls" showed a gain, 8 of one-eighth and 3 of one-quarter of an inch. Among the girls, 3 of the "poorly nourished" and 4 of the "controls" had each gained one-eighth inch in trunk height.

In chest circumference, 5 of the "poorly nourished" boys presented gains ranging from one-eighth to one-quarter of an inch, while 13 of the "control" boys had increase of one-eighth to one-half inch. Chest increase among the girls ranged from one-eighth to half inch, there being 9 of the "poorly nourished" and 8 among the "controls."

It will be remembered that during the first two months the "controls" received no issue of milk. In this period, therefore, it is possible to contrast the increase in weight of normal children with the rate of increase of the poorly-nourished children when assisted by additional milk. During the second period, when all the children received milk, comparison may be made under 3 heads :—

- (1) Comparison of the rates of progress of the "poorly-nourished" during the two periods.
- (2) Comparison of the progress of the two classes of children during the second period.
- (3) Comparison of the rates of progress of the "controls" during the second period, *i.e.*, the effect which extra milk produced on normal children.

The same lines of investigations would hold for the percentage of hæmoglobin.

Referring to the figures given above, it will be seen that during the first two months the increase in weight of the "poorly-nourished" assisted by the milk was considerably greater than that of the "controls." This rate of gain became less in the second two months, the fall being more marked in the girls than in the boys. The "control" boys made great increase during their milk-drinking two months, but the "control" girls gained less than in the first period. They still, however, showed greater increase than did the "poorly-nourished" girls in the same period.

The figures for hæmoglobin present some rather interesting points. The "poorly-nourished" boys made a large gain during the first period, but much less in the second, while the gain in weight was not greatly altered. The "control" boys, on the other hand, varied little in hæmoglobin in the two periods, although the increase in weight was marked in the second two months. One might consider that these individuals had no arrears of hæmoglobin to make up.

In the case of the girls, increase in hæmoglobin was more equal in the two periods so far as the "poorly-nourished" are concerned, although in the later period the increase in weight was much less. The greater gain in hæmoglobin seems here to be associated with a lower gain in weight. If this be so, it would explain the figures in the case of the "control" girls. Here, during their milk-drinking period, their gain in weight was less than in the previous two months, but their increase in hæmoglobin was much greater.

Taking the whole four months, the rate of increase in both weight and hæmoglobin is practically identical for boys and girls of the "poorly-nourished" category. These children taking the

extra milk for four months have increased in weight only a little less than normal children who had the milk for two months, while their increase in hæmoglobin has been very much greater.

The increase in trunk height noted in some cases may be a real gain due to growth, or may be the result of improved general tone comparable with the physiological diurnal variation in height, which may be as much as one-third of an inch.

The teachers of these children kept them under special observation in school, and soon were able to report perceptible improvement in those who were receiving the milk. The children were notably brighter and more lively, and their school work improved, as they seemed less easily fatigued and their concentration was better. The mothers reported general improvement in spirits, and in certain cases better appetites and freedom from headaches were mentioned. It is possible that the improvement in spirits and greater mental alertness may have been due to a temporary stimulation resulting from the ingestion of the nourishment. On the other hand the milk was taken cold, and it seems likely that the process of digestion would tend to produce drowsiness rather than stimulation as an immediate effect.

Although the winter was an unusually mild one there was a good deal of illness of the less serious type among the children in the Allcock Street district. During the course of the experiment six of the boys (four "poorly-nourished" and two "controls") attended the School Clinic. One of the "poorly-nourished" was admitted to hospital suffering from diphtheria. Of the girls, five "poorly-nourished" and one of the "controls" attended the School Clinic. All except the case of diphtheria already mentioned were minor ailments, and it was possible to continue the experiment with these individuals.

In considering the result of the experiment it is necessary to bear in mind the seasonal variation in growth. Throughout the winter months the weekly increase in weight has been estimated to be only about one-half that observed in the summer months, and there is a similar but less well-defined seasonal variation in the case of hæmoglobin.

An examination of the children was made one month after the issue of milk had been discontinued, when it was found that there was a general slight loss in weight.

Average loss in weight one month after stopping milk :—

Boys (poorly nourished)	..	..	..	0.22 lbs.
Boys (controls)	..	..	..	0.09 lbs.
Girls (poorly nourished)	..	..	..	0.18 lbs.
Girls (controls)	..	..	..	0.09 lbs.

The figures for hæmoglobin showed only slight change, there being a small diminution in the percentage in all classes except the "control" boys, where there was a slight increase.

Percentage of hæmoglobin :—

Boys (controls)	..	..	Average increase	..	0.37.
Boys (poorly nourished)	..	..	Average loss	..	0.09.
Girls (poorly-nourished)	..	..	Average loss	..	0.46.
Girls (controls)	..	..	Average loss	..	0.56.

Both teachers and parents reported a diminution in the brightness and spirits of the children concerned.

In order to present a concrete picture of the nutrition of the children and of any changes which have taken place during the four months of the experiment, the so-called "Pelidisi factor" has been calculated for each child. This factor, introduced by Professor Pirquet in Vienna, has been employed throughout Austria in the feeding of children by the various agencies since the war. The formula is :—

$$\frac{\sqrt[3]{\text{Weight} \times 10}}{\text{Sitting Height}} \quad \text{Metric measurement}$$

The lower limit for nutrition in school children is a Pelidisi factor of 94.5, and a child giving a Pelidisi below this figure is under nourished. The normal may be taken at 98. The decreasing Pelidisi implies an increasing degree of under-nourishment. It will be noticed that of the children chosen for the milk, only two boys and three girls had a Pelidisi above 94.5. At the end of the four months eight boys and seven girls had passed this lower limit, and in the case of one boy and one girl only did the factor remain stationary.

In considering the table it must be remembered that the "controls" also received the milk for the second two months.

The average increase in the Pelidisi figure was as follows :—

				First two Months	Second two Months	Total
Boys (poorly-nourished)	..	..	..	1.00	0.86	1.86
Boys (control)	..	..	..	0.33	0.67	1.00
Girls (poorly-nourished)	..	..	..	1.46	0.34	1.80
Girls (controls)	..	..	..	0.86	0.74	1.60

Conclusion.

The following facts may be noted :—

1. A notable improvement in mental and bodily vigour and alertness.
2. Improvement in the hæmoglobin content of the blood.
3. Improvement in rate of increase in weight and in nutrition as calculated by different methods of investigation.

Table shewing the Pelidisi of the " Poorly-Nourished "—

(a) At the beginning of the Experiment.

(b) At the end of the first two months.

(c) At the end of the Experiment.

Boys (poorly-nourished).				At the beginning of the experiment.	At the end of first two months of experiment.	At the end of the experiment.
				<i>Pelidisi.</i>	<i>Pelidisi.</i>	<i>Pelidisi.</i>
Gibbs	..	..	..	98	99	100
Danks	..	..	..	94	95	95
Thorpe	..	..	..	93	93	95
Smith	..	..	..	91	92	93
Tomlinson	..	..	..	95	97	97
Holly	..	..	..	91	89	92
Timmins	..	..	..	90	91	91
Mole	..	..	..	94	95	96
Eaton	..	..	..	93	94	95
North	..	..	..	94	96	97
Hiatt	..	..	..	91	94	94
Claridge	..	..	..	94	95	96
Harris	..	..	..	88	89	90
Ellis	..	..	..	90	90	90
Kelly	..	..	..	90	91	92
GIRLS (poorly-nourished).						
Nicholls	..	..	..	95	96	97
Olds	..	..	..	92	94	94
Dean	..	..	..	96	97	96
Baldwin	..	..	..	95	97	96
Jones	..	..	..	89	91	92
Steventon	..	..	..	94	95	96
Gibbard	..	..	..	92	94	95
Holly	..	..	..	88	89	90
Thrasher	..	..	..	94	95	95
Newman	..	..	..	94	96	97
Darrell	..	..	..	93	94	94
Flanders, F.	..	..	..	88	89	89
Flanders, K.	..	..	..	89	91	91
East	..	..	..	89	91	92
France	..	..	..	94	95	95

Table shewing the Pelidisi of the "Controls."

Boys (Controls).				At the beginning of the experiment.	At the end of first two months of experiment.	At the end of the experiment.
				<i>Pelidisi.</i>	<i>Pelidisi.</i>	<i>Pelidisi.</i>
Pearce	..	..	..	95	94	95
Davis	..	..	..	96	97	98
Timbrell	..	..	..	96	97	97
Wynde	..	..	..	97	97	98
Robbins	..	..	..	93	93	94
Letts	..	..	..	96	97	97
Dainty	..	..	..	95	95	95
Ganlay	..	..	..	97	97	98
Palmer	..	..	..	95	96	98
Fellowes	..	..	..	95	95	97
Bridgland	..	..	..	94	94	94
Brown	..	..	..	92	93	93
Wallbank	..	..	..	95	95	94
Poston	..	..	..	94	94	95
Gill	..	..	..	94	95	96
GIRLS (Controls).						
Thomas	..	..	..	95	96	96
Talbot	..	..	..	100	101	102
Reynolds	..	..	..	96	96	97
Bristlin	..	..	..	95	96	96
Matthews	..	..	..	92	93	94
Shenton	..	..	..	94	95	96
Groom	..	..	..	95	96	97
Hill, E.	..	..	..	93	94	95
Rainsford	..	..	..	96	97	97
Saunders	..	..	..	95	95	95
Brown	..	..	..	95	96	97
Attwood	..	..	..	94	94	96
Hill, K.	..	..	..	95	96	96
Harris	..	..	..	96	98	99
Best	..	..	..	95	96	97

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